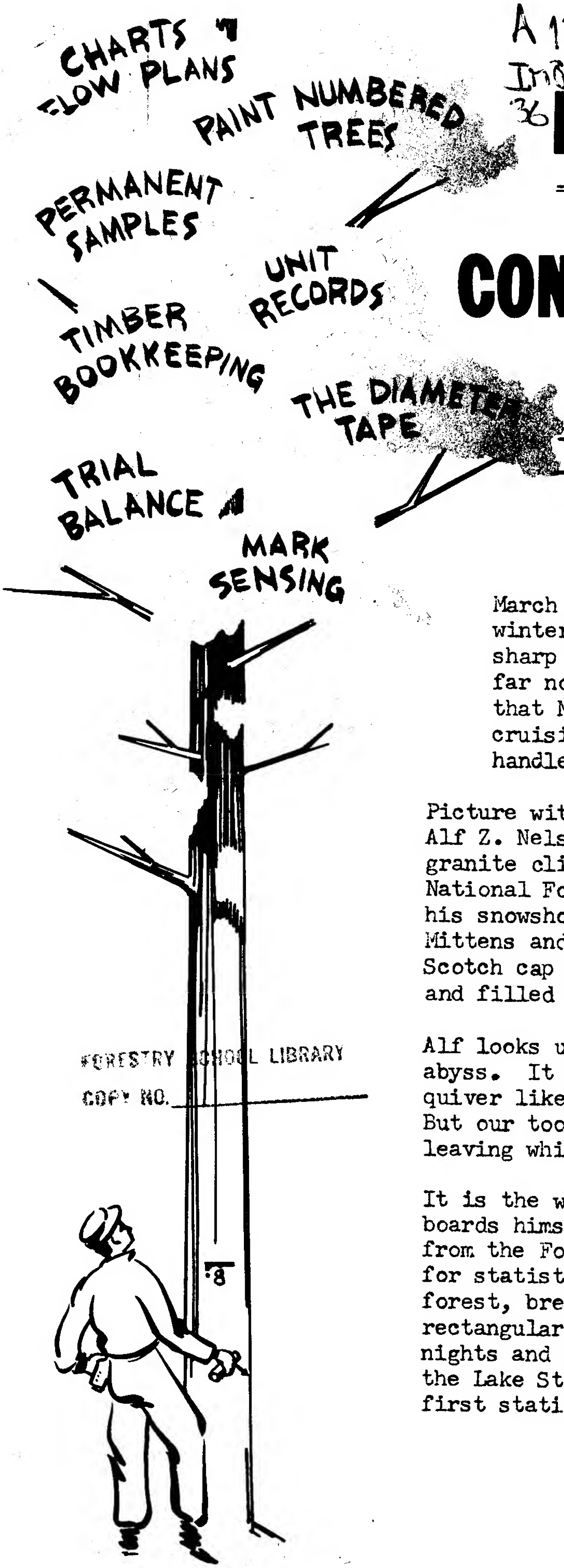
FOREST CONTROL by CONTINUOUS INVENTORY

"---you shall not muzzle an [illegible] treading out the grain."

[illegible]

Milwaukee, Wis. March, 1957 No. 36



FROM THE PAST

March is a cold month in Minnesota. The warrior winter still clings to his terrible throne. His sharp blade the wind, thrusts the forests of the far north through and through. Strange, then, that March should bring warm recollections of cruising jobs and of the cool cruisers who handled them 25 years ago.

Picture with me the arm-flailing figure of Forester Alf Z. Nelson as he jumps from the edge of the sheer, granite cliffs so common to Minnesota's Superior National Forest. He lands with a muffled thud and his snowshoes sink deep into the 10-foot drifts below. Mittens and liners fly into the frosty air and his Scotch cap with ear lappers is stomped under the webs and filled with dry, powdered snow.

Alf looks up to watch my aerial descent into the white abyss. It is made. We shiver with the cold. We quiver like a fat girl's legs encased in summer shorts. But our tools and notes are safe and we trudge on, leaving white fish tracks in the snow.

It is the winter of 1932. Nelson works for nothing and boards himself. Together we have secured permission from the Forest Supervisor to make a sample plot cruise for statistical check. We cover a cold section of the forest, breaking our tally into 320 one-fifth acre rectangular samples. The sheets are hand-computed nights and sent to statistician George Gevorkiantz of the Lake States Forest Experiment Station for our first statistical check.

U. S. Forest Service, R-9
Milwaukee, Wis.

CAL STOTT

The Forester

IN THE PRESENT

Today, twenty-five years later, we still use the same basic principles for statistical checks, but many are the modifications of technique. The job is machine-handled now, and the limit of error of the volumes of a hundred different forest area breakdowns is calculated in a few hours. The statistical accuracy of every stock and stand table is known in less time than it takes to wire the board for the standardized machine formula. The formula is simple, for that is the way Bill Barton, Industrial Forest Consultant for the U. S. Forest Service in Region 7, made it. The steps in the process for a given example are offered in this newsletter, for your review and application.

The Flow Chart Forces Detailed Planning

First, we have a simple but complete flow chart for the work. It begins with the tree detail cards (Deck 1), in which the net volume for each tree has already been computed. These cards are listed and the net total volume for each plot, for all species combined, is summary punched. (Deck 2).

The plot total net volume in each summary card is squared and the cards are then sorted for each area breakdown in succession, and each one is successively listed. For each successive area sort computing cards (Deck 3) are summary punched for the sum of the net volumes; the sum of the net volumes squared and the plot count. There are generally 50 - 150 individual summary computing cards in this deck.

Since some of these area breakdowns (10% - 20%) include only a very low plot count, it is well to exclude these from statistical check. This is done with a sequence sort of Deck 3, by plot count, followed by a hand separation of those cards with less than 5 plots.

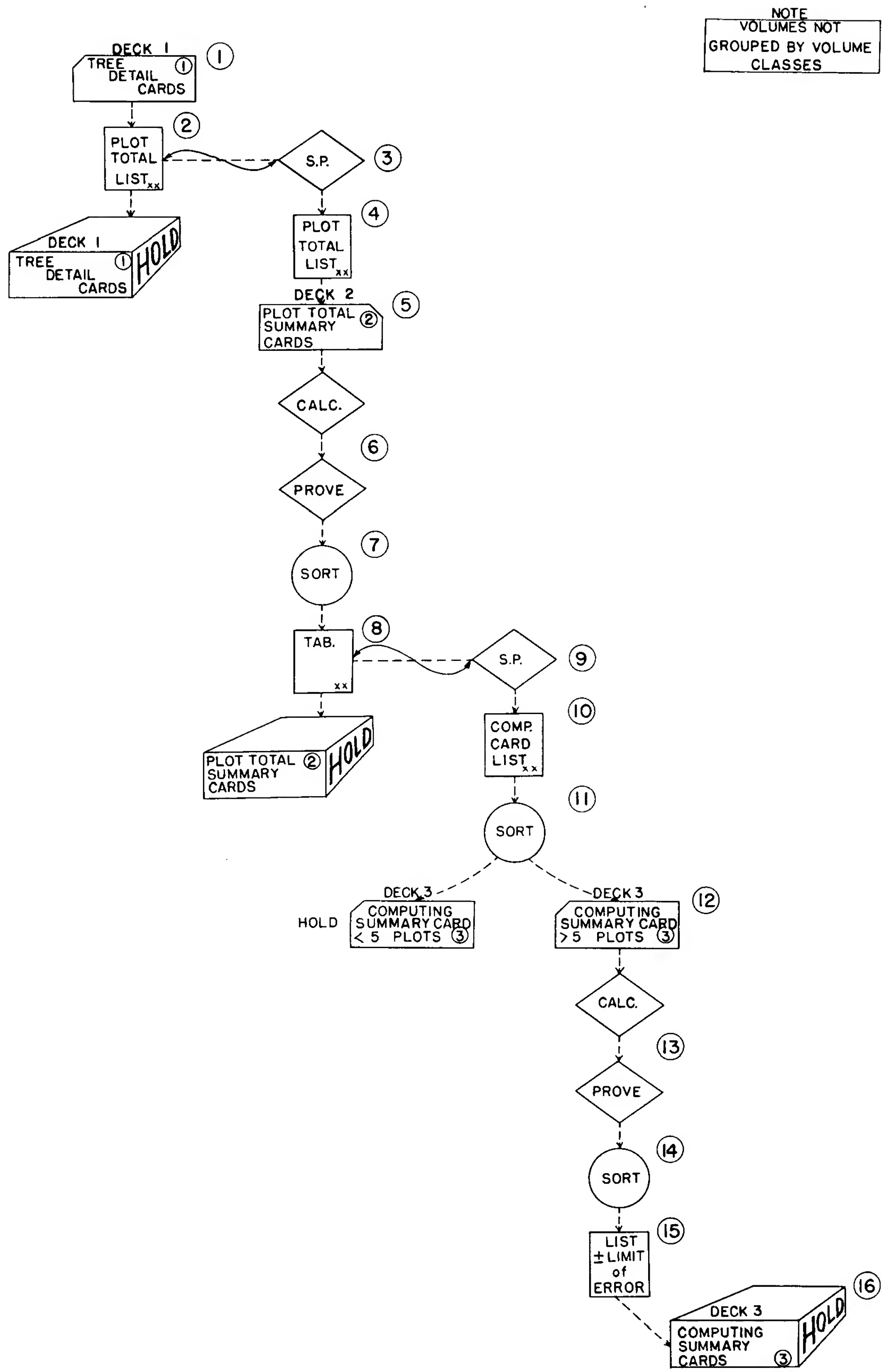
The limit of error is computed for the remaining cards using the formula for the data not grouped by volume classes.

FLOW CHART DETAILS FOR MACHINE MADE STATISTICAL CHECKS USING UNGROUPED DATA

(Flow Chart on Next Page)

FLOW CHART NO.	INSTRUCTIONS
1.	These are tree detail cards with net volumes computed for each tree. Deck 1. Make a card layout.
2.	This is a plot total listing with control totals (xx) and plot count. Make a form layout. Deck 1 to file.
3.	Make summary punch cards with net volume totals for each plot, and include the complete plot description for each area breakdown. Deck 2. Make a card layout.
4.	This is a list of plot total summary cards - Deck 2, with control totals (xx) and plot count. Make a card layout.
5.	These are plot total summary cards. Deck 2.
6.	Calculate and prove the squares of the plot total net volumes in Deck 2.
7.	Sort Deck 2 successively for individual area breakdowns of net volumes which need statistical check. (About 50 - 150, including cover, size, density, site, cutting period, etc.).
8.	Tabulate successively the sum of the net volumes and the sum of the squared net volumes for each area breakdown, with control totals (xx) and plot count. Make a form layout. Deck 2 held in file.
9.	Make computing summary cards, Deck 3, with all data tabulated in Item 8. Make a card layout.
10.	List these totals successively for each area breakdown. Control totals (xx). Make a form layout.
11.	Sequence sort Deck 3 by plot count, and then hand separate cards with less than 5 sample plots. Hold for use in Item 15.
12.	These are computing summary cards Deck 3, for 5 samples or more, ready for the application of Barton's formula for calculating the limit of error on a probability of 95%. Cards with less than 5 plots to be held for later use.
13.	Calculate and prove the limit of error for cards with 5 plots or more. See following formula and sample hand calculation.
14.	Sort into the original area breakdowns, for all cards, with 5 plots or more.
15.	This is a listing of the limit of error for each major area breakdown. Include in this listing the cards with less than 5 plots which were not computed for the limit of error.
16.	All computing summary cards, Deck 3, are held for use.

FLOW CHART FOR MACHINE HANDLED STATISTICAL CHECKS



FORMULA FOR CALCULATING THE LIMIT OF ERROR

$$E = 2\sqrt{\left(\frac{N \Sigma X^2}{(\Sigma X)^2} - 1\right) \div (N-1)}$$

IN WHICH

E = Limit of error for a probability of 95 percent

N = Number of sample plots

ΣX = Sum of the net volumes in each sample plct

ΣX^2 = Sum of the squares of the net volumes in each sample plot

$(\Sigma X)^2$ = Sum of the net volumes of each sample plot quantity squared.

HAND CALCULATED EXAMPLE OF FORMULA FOR STATISTICAL CHECK DEVELOPED FOR MACHINE USE

ITEM	FORMULA	COMPUTED RESULT	PUNCH IN COLUMN NOS.
NO. OF PLOTS	N	75 PLOTS	7–10 XXXX.
SUM OF NET BD. FT. IN EACH PLOT	Σx	121,841 BD. FT.	11–18 XXXXXXXX.
SUM OF SQUARES OF NET BD. FT. IN EACH PLOT	Σx^2	241,029,015 BD. FT.	19–30 XXXXXXXXXXXX.
SQUARE OF SUM OF THE NET BD. FT. IN EACH PLOT	$(\Sigma x)^2$	14,845,229,281 BD. FT.	31–43 XXXXXXXXXXXXX.
B FACTOR	$\frac{N \Sigma x^2}{(\Sigma x)^2} - 1$	$\frac{18{,}077{,}176{,}125}{14{,}845{,}229{,}281} - 1$	44–51 XX.XXXXXX
B FACTOR ÷ NO. OF PLOTS MINUS 1 PLOT	$\frac{B}{N-1}$	$\frac{00.217709}{74} = 0.002942$	52–58 X.XXXXXX
THE LIMIT OF ERROR PROBABILITY 95%	$2\sqrt{\frac{B}{N-1}}$	2 X .054 = 0.108 OR $\boxed{11\%}$	59–62 X.XXX

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THIS IS THE COMPUTING SUMMARY CARD LAYOUT
FOR THE STATISTICAL ANALYSIS OF UNGROUPED DATA

STONE'S WOOD
NINE YEAR
RE-INVENTORY
1955

DECK 3

INTERPRETER SPACING

①		COVER SIZE DENSITY SITE AGE ETC.	1–6
②	N	NO. OF PLOTS	7–10
③	Σx	SUM OF NET PLOT VOLUMES	11–18
④	Σx^2	SUM OF SQUARES OF NET PLOT VOLUMES	19–30
⑤	$(\Sigma x)^2$	SQUARE OF SUM OF NET PLOT VOLUMES	31–43
⑥	B-FACTOR	$\frac{N \Sigma x^2}{(\Sigma x)^2} - 1$	44–51
⑦	$\frac{B}{N-1}$	B FACTOR / N-1	52–58
⑧	ERROR	$2\sqrt{\frac{B}{N-1}}$ ①	59–62
			63–80

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① LIMIT OF ERROR TO A 95% PROBABILITY IS EQUAL TO $2\sqrt{\frac{B}{N-1}}$

NOTE

IF NEEDED THE COEFF-ICIENT OF VARIATION square MAY BE COMPUTED

THE FORMULA IS

$C^2 = B \times \frac{N}{N-1}$